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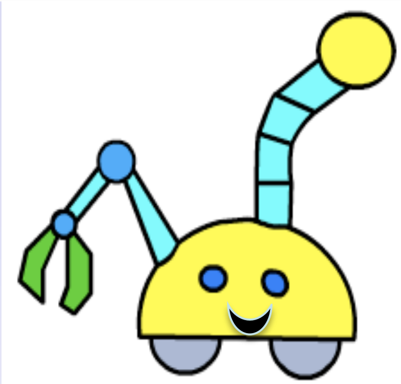

Math CAMPPP 2011

Plenary 5

Supporting Struggling Learners

CLIPS

Learning Disabilities and Algebra

- Most research to date has focused on elementary school content – particularly basic number concepts and simple arithmetic
- Little research has been done on the algebraic understanding of students with Learning Disabilities
- Recently the National Assessment of Educational Progress (NAEP) reported that 75% of eighth-grade students with learning disabilities scored below the mean score for the full sample in Algebra and Linear Relationships

Instruction for Students With LD

- Divide between procedural and conceptual instructional practices
- Instructional approaches for these students tends toward memorization through repetition rather than the development of conceptual knowledge
- Rote drill may offer students a means of producing the “right answer” but it is an extremely limited way of understanding complex algebraic concepts

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Instruction for Students With LD

- In contrast, conceptual understanding is the thoughtful and connected learning of mathematical principles and concepts – leading to an understanding of *why* and *how* mathematical concepts are related
- Linear relations is a fundamental area for later math, and these students should NOT be excluded from this area of mathematics (Algebra as a gateway)

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Prioritizing Visual Representations

- The approach we've been using prioritizes the building of linear patterns and the construction of graphs
- Initially we ground patterns in the context of Input/Output (position number as Input and number of tiles as Output) to provide a solid start for establishing the idea of invariance, and the dependent and independent variables

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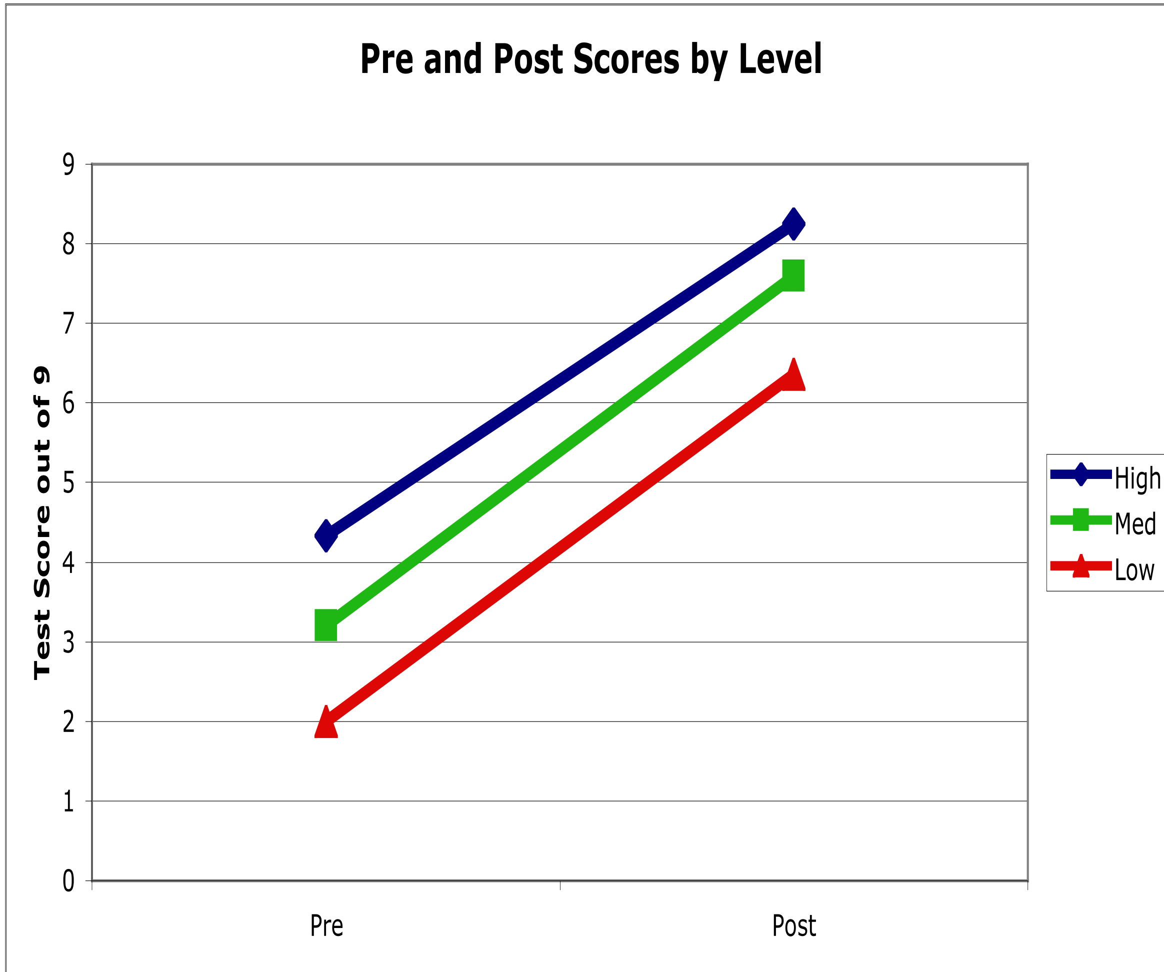
Past Research

- We have found that this approach supports all levels of students, including those who have been identified with some form of learning disability



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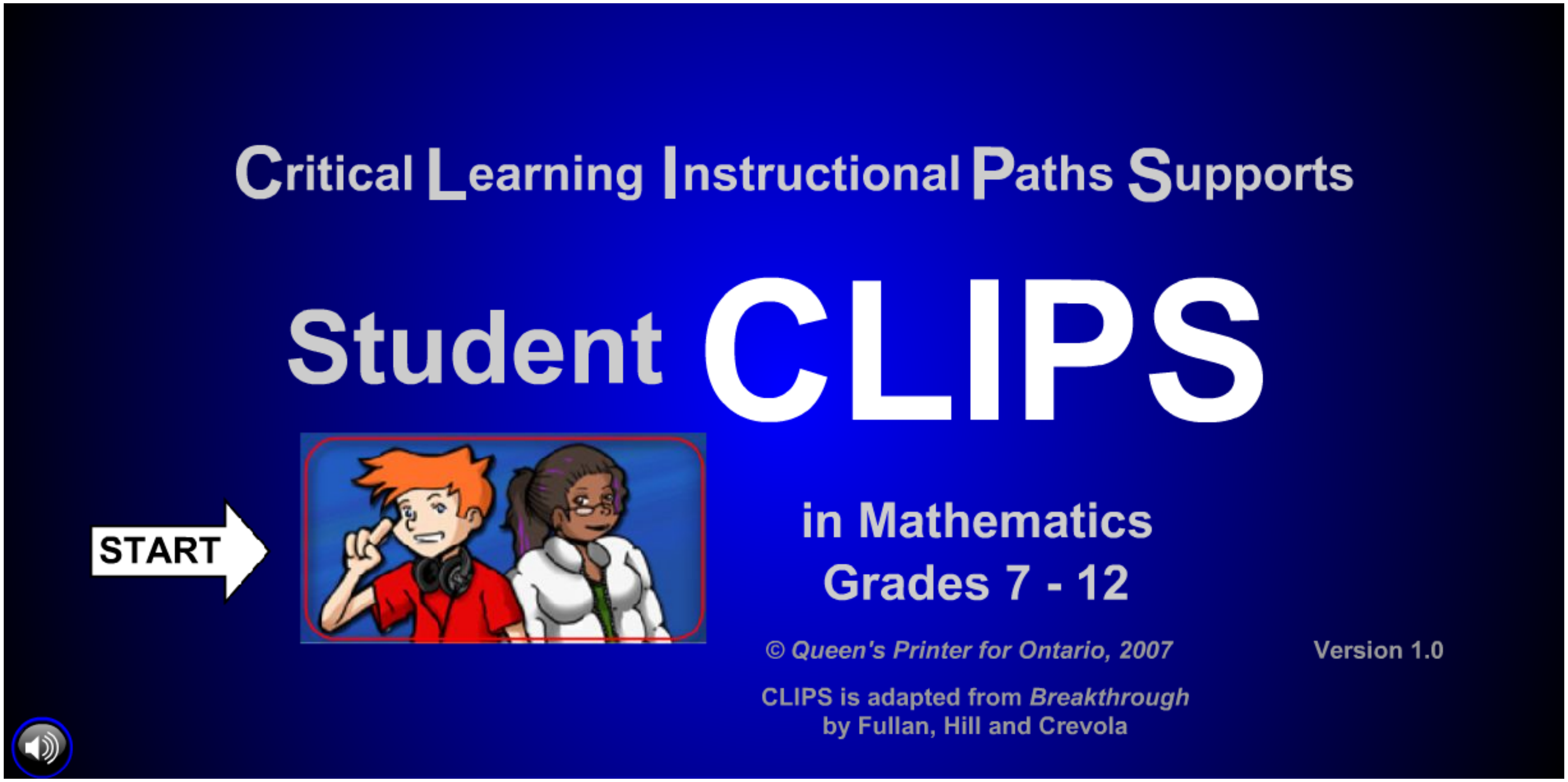

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CLIPS

- CLIPS is a series of computer based interactive learning objects
- Combines a proven visually-based curriculum with the unique properties offered by digital technology
- CLIPS incorporates a graduated teaching sequence that proceeds along a continuum from concrete iconic representations (patterns) through more abstract representations (graphs) to symbolic notation

Four Kinds of Activities

- **Minds On** – introduce math concepts. Structured scenes that have opportunities for student interaction
- **Action** – extend concepts introduced in the Minds On activities. Allow for a great deal of student engagement and interaction
- **Check Your Understanding** – consolidation activities that offer students the opportunity to answer a variety of questions, and to use tools such as the pattern building tool and graphing tool
- **Show What You Know** – allow students to further explore material covered in this cluster.

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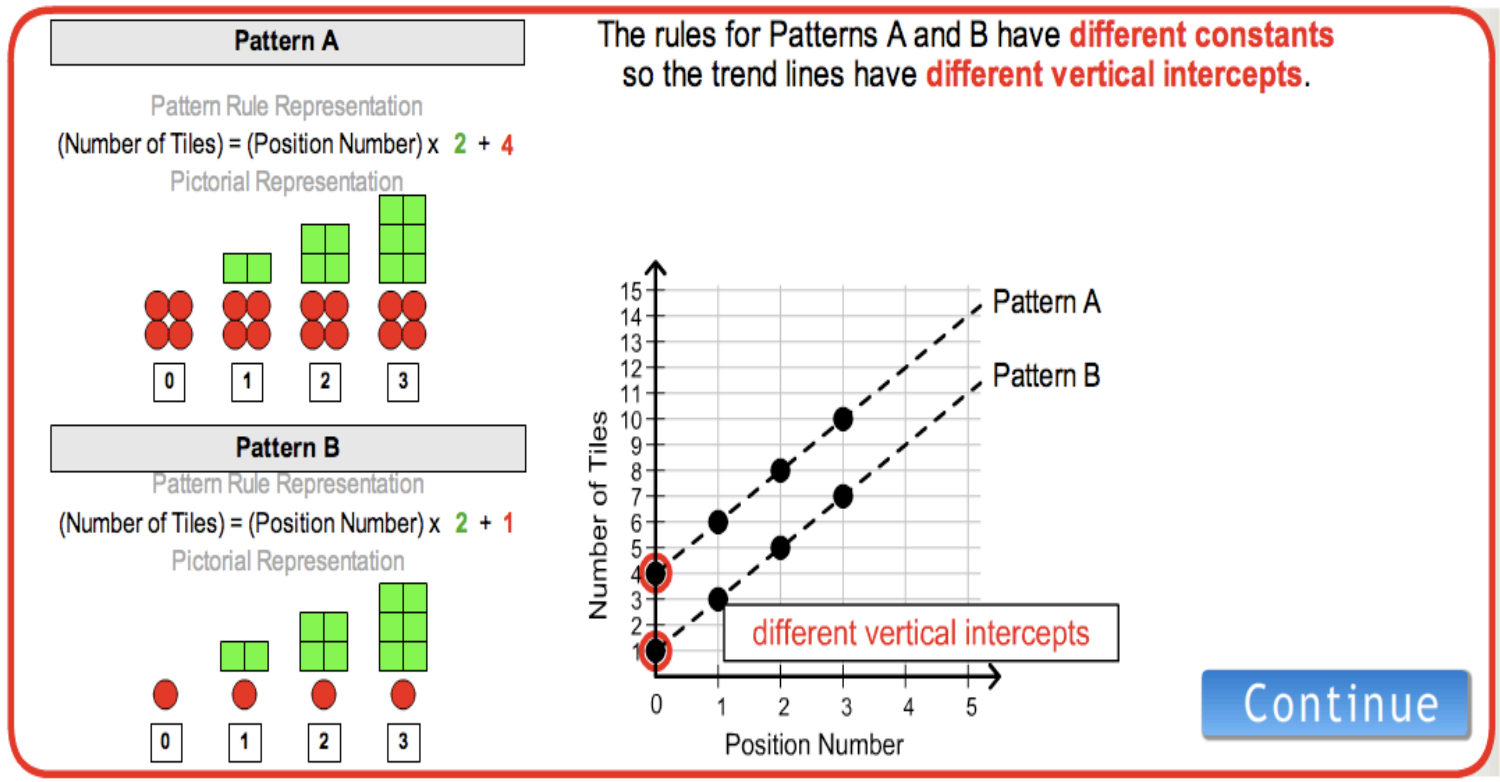
Instructional Components

- CLIPS incorporates instructional components identified by many researchers as vital for students with LD (Fuchs et al., 2008; Fuchs et al., 2006; Montague, 2007; Fuchs & Hamlett, 1989; Swanson & Hoskyn, 1999; Anderson-Inman et al., 1996)
  1. Focusing attention
  2. Student interaction with dynamic representations to construct understanding
  3. Multiple opportunities for practice
  4. Modeling with representative examples
  5. Immediate leveled corrective feedback

Focusing Attention

- Previous research indicate students with LD often display attention difficulties
- CLIPS was designed to direct students' attention to aspects we believe are important
- For example the connection between the numeric value of the constant, the number of tiles in a pattern that "stay the same" and the *y*-intercept of the trend line

Focusing Attention



In addition all activities have audio narration that directs students' attention to particular aspects of each task

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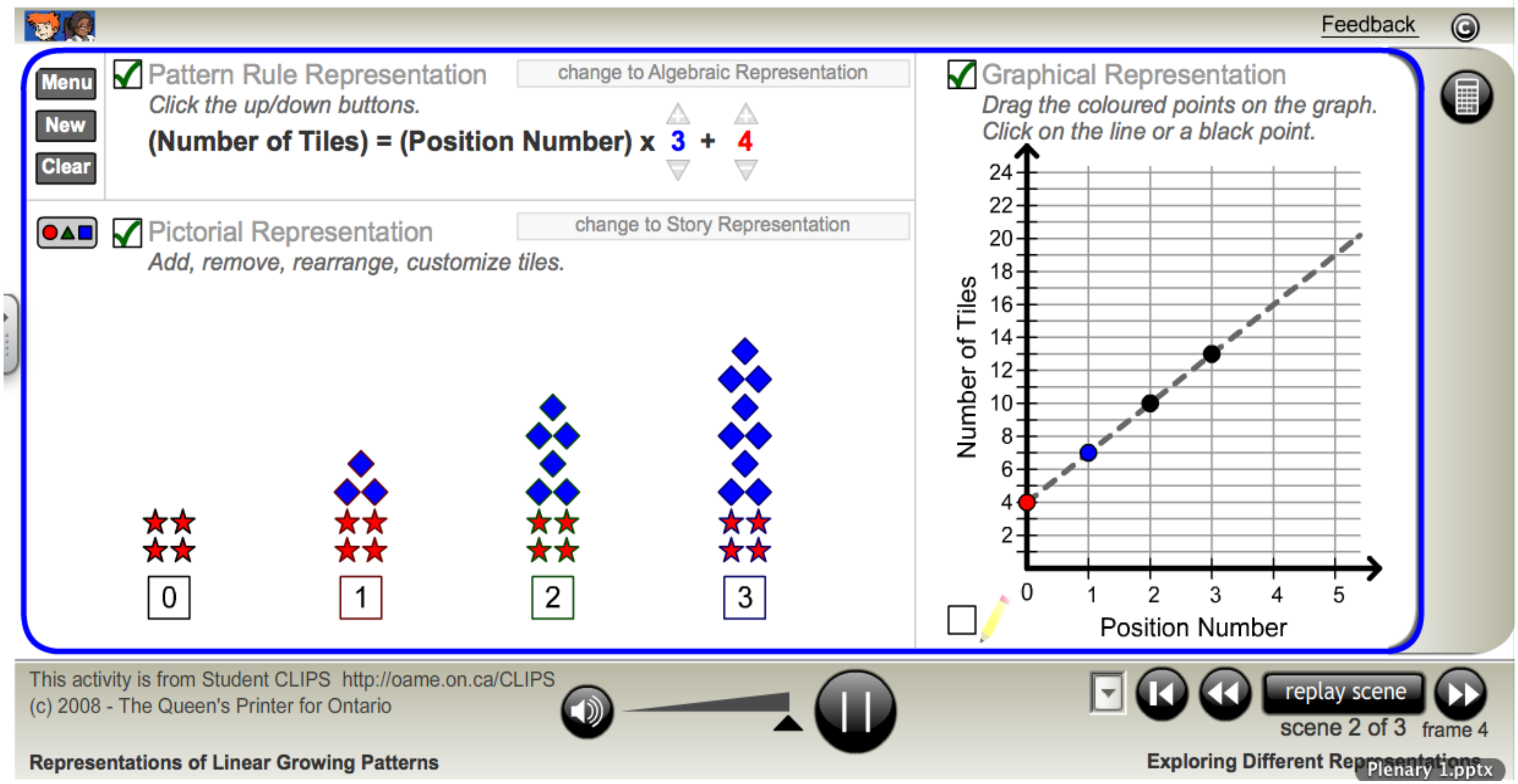
Interaction

- Mathematical connections can be conveyed in ways not possible without animation
- Students work with dynamic learning objects that are constructible, manipulable, and interactive
- This offers students with LD an opportunity to *construct* an understanding of linear relationships rather than memorizing rote facts

The Über Tool



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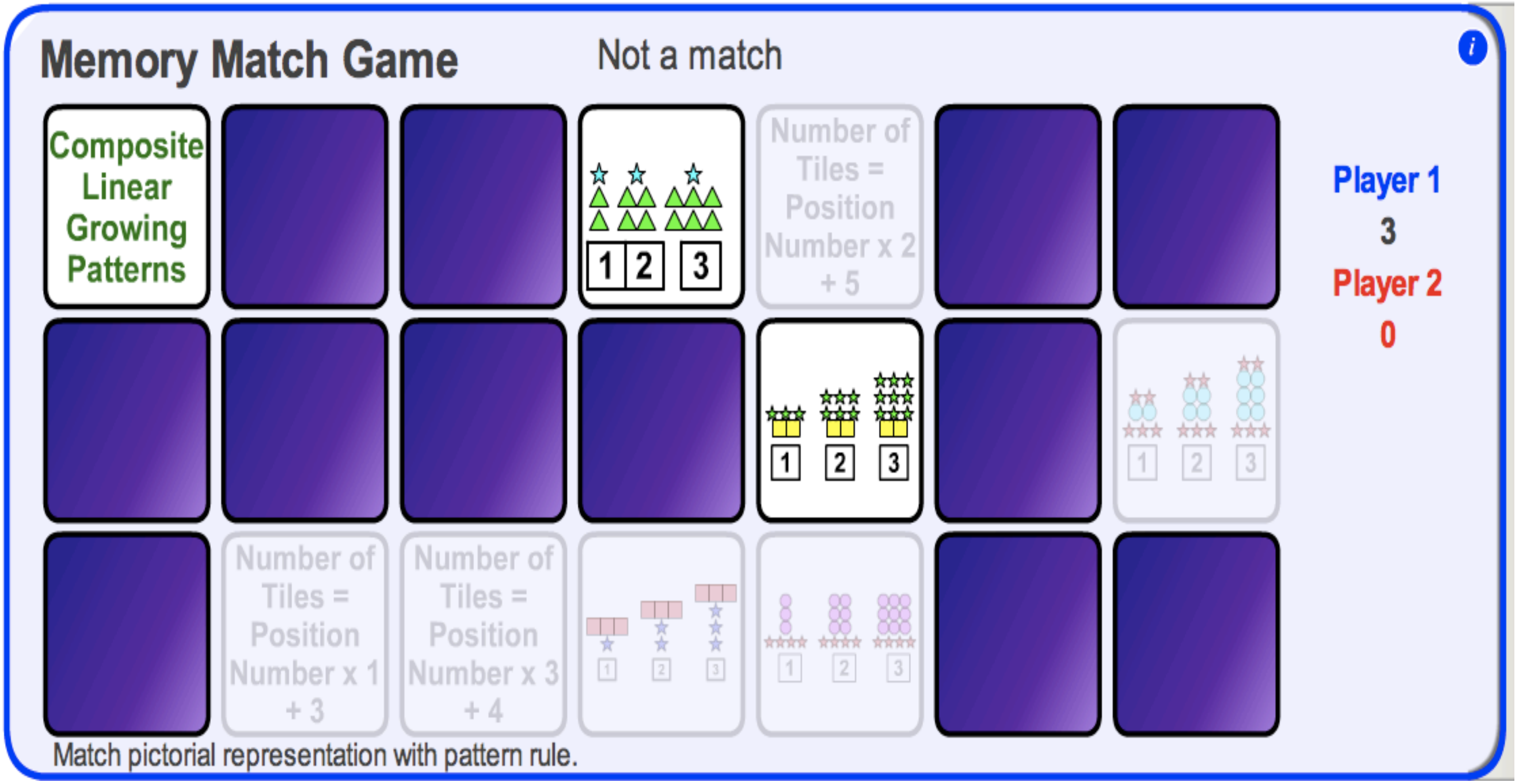
Multiple Opportunities to Practice

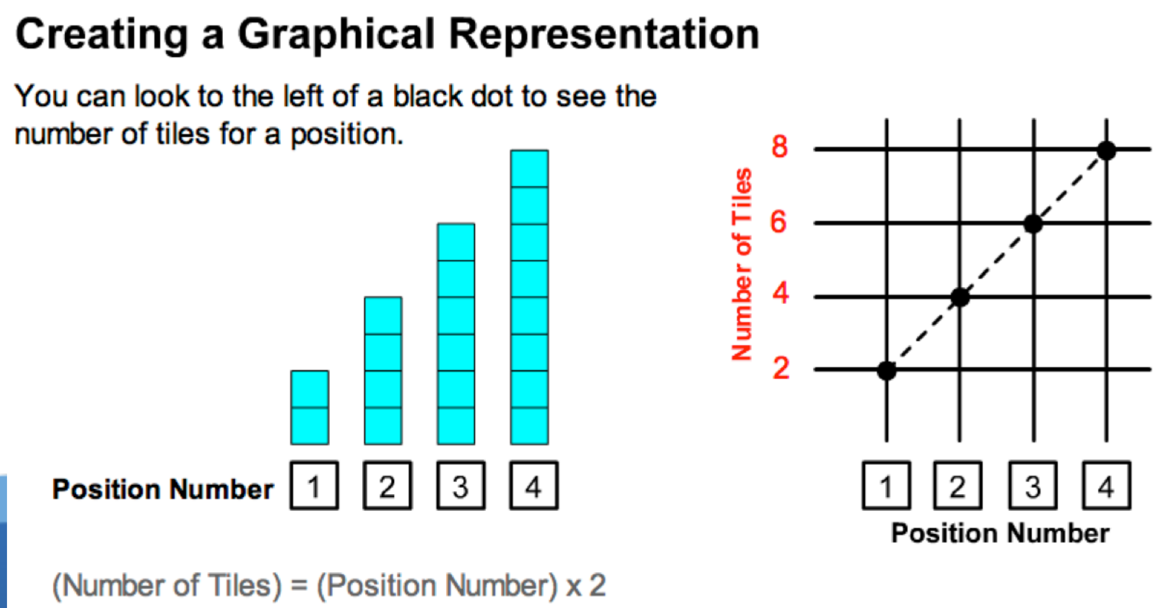
- Activities are no more than 5 to 10 minutes in length
- Each builds onto the concept of the previous activity
- All activities are interactive
- All activities can be replayed, as many times as needed/wanted
- Games are incorporated to provide more practice opportunities

Multiple Opportunities to Practice



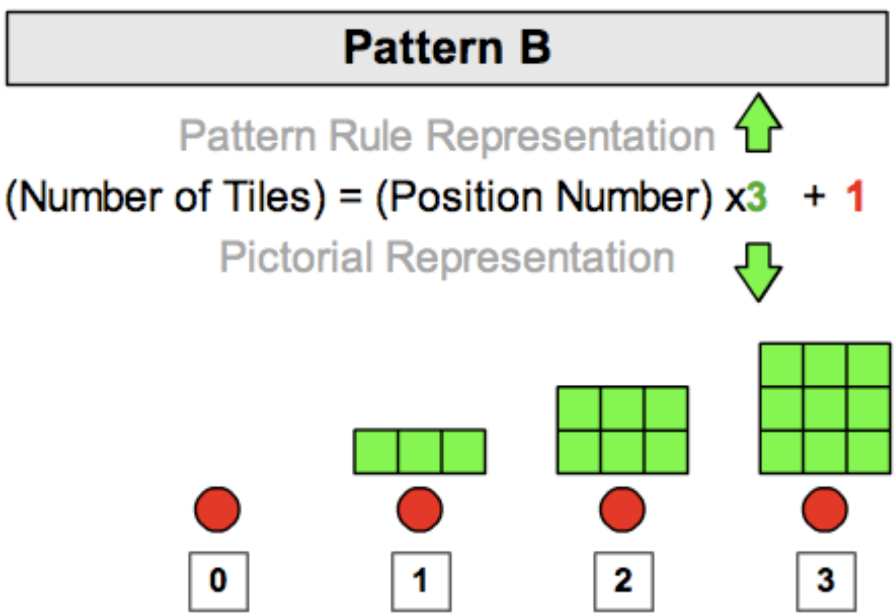
Modeling with Representative Examples

- Concepts are first introduced through **Minds On Activities**
- For example, in Creating a Graphical Representation students are introduced to the connection between patterns and graphs

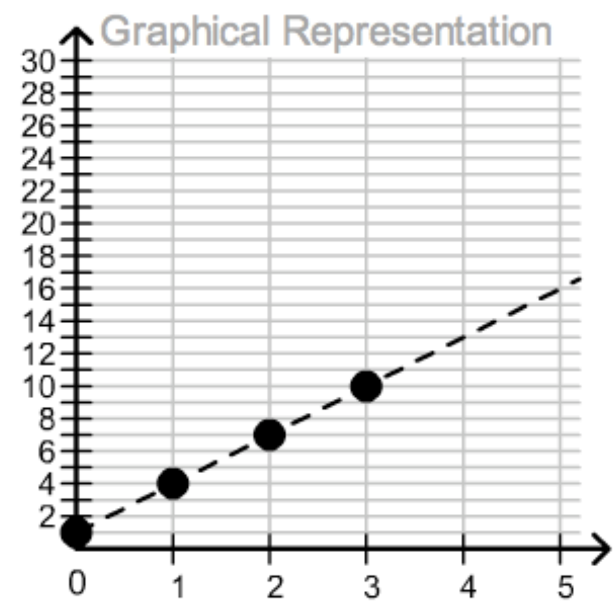


Modeling with Representative Examples

- Students then get a chance to practice by engaging in **Action Activities**



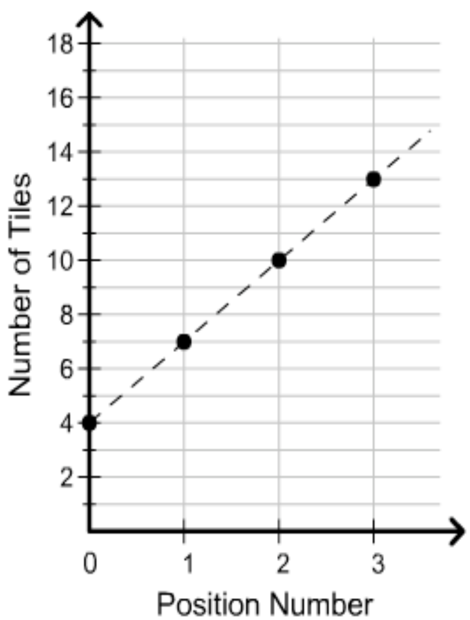
Increase or decrease the multiplier in the rule for Pattern B by clicking the up or down arrow. Try several different multipliers.



Modeling with Representative Examples

- Finally students can assess their learning using **Check Your Understanding** activities

This is a graphical representation of a pattern built using the rule:
(Number of Tiles) = (Position Number) x 3 + 4.



Fill in the boxes to complete the rule for a pattern whose trend line is ***parallel*** to the one shown.

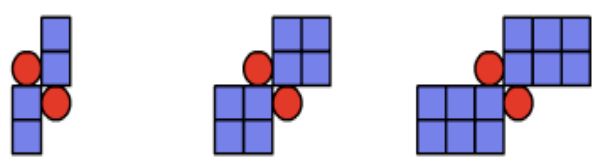
(Number of Tiles) = (Position Number) x $\boxed{3}$ + $\boxed{3}$ Check

Immediate Leveled Feedback

- Feedback is designed to scaffold student understanding by including different levels of prompts, depending on the answer entered, or on the number of times an incorrect answer has been entered

Check Your Understanding

This is a pictorial representation of Positions 1, 2, and 3 of a pattern:



1 2 3

Enter the constant for this pattern's rule into the box below and then click Check.

Pattern Rule Representation: (Number of Tiles) = (Position Number) x 4 + 4

Check

Incorrect.
Look at each position to see what stays the same in each position. **Try again.**

Overview of Research Study

- 17 teachers (Grades 7 and 8) in two school boards were invited to assess the effectiveness of CLIPS
- 342 students – 10% identified as LD
- Teachers participated in three Professional Learning sessions during the study
- Between the Professional Learning sessions, researchers observed classroom implementation of CLIPS

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Results

- Four themes emerged
- Two anticipated results
  - Increase in student achievement (linear relationships)
  - Students constructed conceptual understanding (not rote memorization)
- Two unanticipated results
  - Inclusive classroom community
  - Increase in student confidence

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Student Achievement

- Teachers reported that students with LD who worked with CLIPS were able to:
  1. Determine the explicit rule for linear growing patterns
  2. Create a graph given a pattern rule
  3. Determine the explicit rule, given a graphical representation
  4. Make connections among the three representations – pattern rules, patterns and graphs

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Student Achievement

- Teachers' in-class assessments revealed that students with learning disabilities were able to make connections among different representations of linear relationships, and how changes in one representation would affect the other representations

> With confidence I can say all my students with a learning disability can look at a graph and tell you the rule for that graph, can build a pattern from that graph, and give you a story related to that graph. I've never had that experience before. On the quizzes and assessments I've been doing, they've all been getting level 4 [out of 4].

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Constructing Conceptual Understanding

- Teachers reported that students constructed an understanding of linear relationships through their engagement with the material
- For example, a teacher talked about her student who was puzzled about trend lines that had a *y*-intercept other than 0

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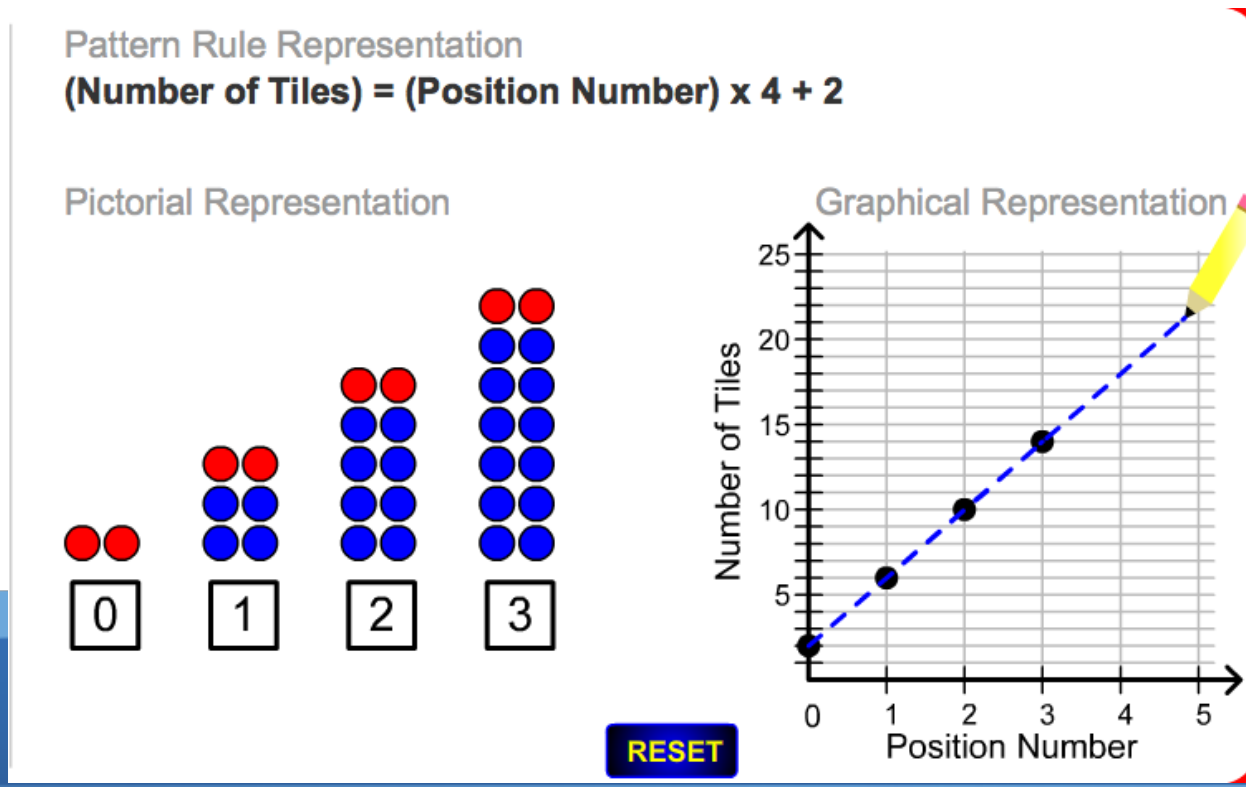
One of my students said to me the other day, “Ah, so I get it. The graph doesn’t always have to come from 0! I thought I’d drawn my line wrong, and then I realized …” because she had thought that all the lines had to start at the origin. But then she figured out that this wasn’t the case. She figured out that the *y*-intercept shows the number of tiles that would be at the 0 position of a pattern…



… This is the kind of thing I'm seeing a lot with the identified kids, the kids not working at grade level. They're making comments like, "This makes sense! If math was like this all the time, it'd be great." Because they can figure it out. They can work at it and *figure it out themselves*. (Grade 8 Teacher)

Inclusive Classroom Community

- Students worked alongside peers engaging in the same activities

All my students with learning disabilities were doing what everyone else was doing – all the same lessons. And they're doing fine! That's huge! That these kids can engage in the same activities and communicate their thinking to the class! There was no Individual Education Plan in place for this. They all did the exact same thing and I did not accommodate any student at any time for this. And everyone did well. (Grade 8 teacher)

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Increase in Student Confidence

- Teachers reported they perceived an increase in the confidence of students with LD in math class
- They cited both an increase in student attendance and contribution to discussions

> The biggest difference for me was seeing kids with LDs who are normally petrified of math, and not terribly successful, and believing that they can't do it, actually leading the discussion. One of my self-proclaimed weak math students got the concept and was questioning typically stronger math students in class about their patterns and explaining why it wasn't a linear growing pattern – that the growth wasn't predictable. (Grade 8 Teacher)

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Educational Contribution

- Sequenced dynamic representations of linear relationships had a positive effect on the levels of achievement of students identified as having a learning disability
- CLIPS allowed students to construct deep conceptual understanding of complex algebraic relationships rather than memorize procedures

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Educational Contribution

- Students with LD became participating members of the classroom mathematics community
- If students are treated as though they have the capacity to engage with complex materials and concepts, and are supported through flexible, dynamic sequences, it appears they can transcend expectations
- Much more research is needed

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